

## FOSSIL FOOTPRINTS IN CHINA

YOUNG CHUNG-CHIEN

(Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica)

### INTRODUCTION

Since the first record on a fossil footprint made in 1929 by late Père Teilhard de Chardin and the present writer from Shenmu, N. Shensi our knowledge concerning this special branch of vertebrate paleontology is greatly advanced. Besides the rich and famous finds of *Jeholosauripus* from Chaoyang, Liaoning Province (then Jehol Province), *Kuang-yuanpus* from Kuangyuan, N. Szechuan and some other traces of fossil footprints from various places collected or observed and studied before the war, at least three localities with well preserved fossil footprints were discovered by several geological field parties recently. In addition, many new specimens of *Jeholosauripus* have been collected by Mr. H. T. Liu and others of our Institute in 1954 from the type locality and a new site with apparently the same form was recovered near Chengteh, Hopei recently. All these facts enable us to have a fairly good idea concerning the fossil footprints in China as compared with what we knew about thirty years ago.

In the following pages I shall try to make some critical review of the known forms. The descriptions of the new ones are also given. Then, some points on the zoological and stratigraphical considerations are drawn as conclusion.

### REVIEW OF KNOWN FORMS

#### 1. Fossil footprint from Shenmu, N. Shensi

Teilhard de Chardin, P., and Young, C. C. 1929.  
Kuhn, O., 1958.

This oldest known fossil footprint in China has been recently renamed by Kuhn as *Sinoichnites youngi*, n. g. n. sp. without a new diagnosis of it. Since the original specimen is not at my disposal I feel I have nothing to add to what have been previously described. Systematically, it is certainly belonging to an ornithopod closely related to *Iguanodon*. The geological age of the Shenmu specimen is, however, less clear. In our paper we regarded it as belonging to upper Jurassic tentatively and not as Cretaceous as given by Kuhn. According to the current geological map of this area there is even no upper Jurassic rocks developed in that region. As far as the size and the structure of the specimen can be shown, an older age of it is quite improbable.

2. Fossil footprints from Kaungyuan—*Kuangyuanpus szechuanensis*

Young, C. C., 1943.

Kuhn, O., 1958.

There is also little to add to what I have previously described for this form. Kuhn suggests that this form may belong to a saurischian dinosaur. But the vertebrate fauna of this area is poorly known and the saurischian remains there are represented by teeth only. Stratigraphically it is not absolutely impossible that age of *Kuangyuanpus* may even be older than Upper Jurassic, as based upon the recent observations by invertebrate paleontologists<sup>1)</sup>. This view is not in contradictory to my own observations in the field that the footprints-bearing horizon is not far from the Triassic Hsuehiaho Series immediately below the Kuangyuan Series.

3. Footprints from Yangshan, Chaoyang, Liaoning—*Jeholosaurupus s-satoi*

Yabe, H., Inai, Y. and Shikama, T., 1940.

Shikama, T., 1942.

This species of footprints represent so far the richest and most well preserved form known in China. The whole collection made by Japanese paleontologists has been identified and described subsequently by Yabe and others. Their described specimens are nearly 200 and those observed in the field are 4,000 in a limited area only.

In 1954 a field party (Plate I) of our Institute has been sent to the very place, Ssuehiazu, near Yangshan, Chaoyang, and a pretty well collection of the same form of footprints has been made. Thirty-nine pieces of various size of specimens with at least 67 more or less well preserved footprints have been collected. This collection is particularly interesting because the facts that the types are kept abroad and the much richer specimens later described by Shikama are apparently lost.

In addition a new locality with surely the same form of footprints was located by the Hopei Geological Bureau recently. The exact place is: Lotoshankou, Liukou, Chengteh, the capital city of the former Jehol Province and now belongs to Hopei Province<sup>2)</sup>.

It is therefore obvious that some new observations could be made of this very interesting species of foot prints based on those new finds. They are given in the following lines.

**1. Description of the new material from Yangshan.** Although the new collection is very good but so far as we can judge now, they are within the scope of what Yabe and others have been previously described. According to Shikama, the ranges of his specimens studied are as follows:

1) Personal communication of Mr. C. V. Kuo.

2) 河北承德六沟骆驼山沟。

Table 1

Total maximum length .....	70—120 mm
Maximum distance between the lateral tips .....	50—85 mm
Length of the second digit .....	33—70 mm
Length of the third digit .....	41—95 mm
Length of the fourth digit .....	23—80 mm

In our collection there is no single specimen of which the size is not included in the above table. Also the divergent angle of the base of the footprints as well as that between the digits are very much the same as described by Shikama. Of course, as already observed by Shikama, the shape and the size are very variable which are caused both by the age of the animal and by the strength with which the animal trod the ground.

On the other hand, our collection is by far less satisfactory, because most of the prints were collected isolatedly, at least impossible to put them together in the laboratory. Among all the specimens, the best one contains seven prints only which is surely in original relative position and seven slabs with three to four prints preserved. The remaining of them are in isolated condition containing either one or two prints or only some fragments of them. It is, therefore, difficult to make sure of the distance of steps or other observations. But since those footprints are so similar to the much rich finds described by Shikama, I would be inclined to rely upon the observations made by the named author.

**2. The description of the footprints from Chengteh.** The mentioned slab with six prints in roughly two rows as shown in the plate II. The slab is made of calcareous coarse sandstone with occasionally small pebbles, exactly as the rock of Yangshan. We have reasons to believe both are correlative in stratigraphical sequence. Unfortunately there is no further data concerning the occurrence of the specimen. Cat. no. IVPP. V2474.

All the prints are well preserved. Two of them show cushions of the segmentation. Although there are two rows (the left side two and the right side four) but they are belonging certainly not to the prints of one animal on account of the wide divergency in direction and all of the prints belong to the left side. On this slab there are two distinct furrows and one part with some relief and depression as shown clearly in the photograph. They are certainly nothing to do with the maker of the footprints as for instance the trace of the tail or impression of other part of the animal, because the furrows are transversally oriented with the footprints and the irregular surface is quite obscure. All of them are clearly marks of the surface of the exposed layer of the deposits when the prints were made by the animals.

As concerning the footprints, the two of the left row are larger but still within the maximum limit, that is 120 mm in length of *Jeholosauripus*. At the right only two of them are well preserved while the other two are less distinct. Two of them are located near by each other, suggesting that they are made by two animals. In all the prints, the heel part of the foot is either total absent or poorly indicated proving that they are made by a running pose.

In none of the footprints there is no one with trace of the hallux preserved, while the tips of the claws are clearly indicated in some of the digits.

Table 2 Measurements of the well preserved footprints (in millimeters)

Total length .....	113	115	103	106
Distance between the lateral tips .....	74	80	64	64
Length of II .....	54	58	43	43
Length of III .....	68	78	66	63
Length of IV .....	63	61	48	48
Divarication of II and IV .....	28°	34°	25°	22°
Divarication of II and III .....	15°	16°	14°	12°
Divarication of III and IV .....	13°	14°	12°	12°

So far as the measurements are concerned, they are within the limits given by Shikama for *Jeholosauripus*. The various divarications fit also with the named species. It is, therefore, beyond doubt that the footprints from Chengteh belong to this very form and certainly of the same geological horizon.

3. Systematic position of *Jeholosauripus*. Shikama has compared the Chinese footprints with the genus *Grallator* of the Newark Series of N. America. Based upon my present study of the remains from Yangshan as well as the new material from Chengteh, I would be inclined to believe that Shikama's identification is right.

Before this study, however, Dr. Donald Baird of Princeton, New Jersey has kindly informed me about some of his observations on the *Jeholosauripus*, of which I am deeply thankful to his kindness. In one of his observations, he considered *Jeholosauripus satoi* as the synonym with *Anchisauripus* as he noticed in his paper (1957) and his letter by saying that the Chinese species falls within the range of variation of this American form. During my present study I noticed that the size of the Chinese form is well limited as a species but not as the genus as Dr. Baird used to compare. In addition I failed to find any trace of the impression of the hallux so commonly found in the species of the genus *Anchisauripus*. Although he suggests that the absence of it may not prove that it should be excluded from this genus, but I would think the total absence of the hallux in such a large collection can not be considered as merely accidental.

Based on those observations and in consideration of the wide geographical distance of the localities of those forms and as well as the less clearly geological age of our specimens I would rather be inclined to consider *Jeholosauripus* as an independent genus, which is closely related to *Grallator*, instead of *Anchisauripus*.

The diagnosis of the genus *Jeholosauripus* may be re-given below, largely based on its original writers:

Footprints of plantigrade animal. Tridactyle without trace of hallux and lateral digits as well as caudal impression. General outline deltoid. Proximal end of III starting much anterior to that of II and IV. Size rather small.

4. Geological age of *Jeholosaurus* *s-satoi*. As far as the morphological characters of the footprints are concerned, there is little doubt that the age of the footprints-bearing strata are upper Triassic in age. The general features of the prints are so closely related with those of the Upper Triassic Newark Series of N. America that the Chinese form may even be considered as the synonym of one of the genera of that formation and that one is difficult to distinguish a single print of the Chinese form that of the corresponding form of the Newark group.

Nevertheless the age of the mesozoic strata of those area with remains of footprints are in dispute for a long time. There is no other definite prove of the presence of Upper Triassic horizon in those regions. In addition as Dr. Baird correctly pointed out in his letter to me that the Triassic footprints may have survived the end of Triassic. After all footprints are not good indicators of the determination of the age of deposits. One thing is, however, clear that the *Jeholosaurus*-beds lie below the beds with *Lycoptera*, *Yabeinosaurus* and *Menjurosaurus* which are of Upper Jurassic age. In addition it seems hard to believe that the morphological type of the footprints like *Jeholosaurus* *s-satoi* may extend to a level higher than the Lower Jurassic. Therefore I would put at present the age of *Jeholosaurus* at most Lower Jurassic, if it is not Upper Triassic. In other words, to consider the age of *Jeholosaurus* as Raetic-lias is certainly a safe conclusion at present.

As far as the tetrapods are concerned (the fishes and the insects are under study now and there is still no available data to be used.) the stratigraphical distribution of the known forms may be given in table 3.

From table 3 it is clear that the vertebrate fauna besides the fishes is richly represented in the Upper or Middle Jurassic time while the other horizons are rather poorly represented. It is to be hoped that some additional forms will be found besides the footprints so we could in better position to give the precise age of all the deposits. It must be noted that the general sequence of the deposits is not unsimilar to that of the Lufeng Series. It is very probable that some day we may find a new real Upper Triassic vertebrate fauna from the *Jeholosaurus*-beds. Both according to the morphological characters of the footprints and the stratigraphical evidences, it is out of question to regard the age of *Jeholosaurus* as belonging to Cretaceous as suggested by Kuhn (1958, p. 27).

5. The "lost" footprints in China. In my previous paper on Kuangyuan footprints, I have mentioned some of such tracks observed elsewhere. They are of course impossible to add anything concerning their true nature.

In the meantime additional observations on the footprints have been reported. One is a slab with at least five footprints from the lower division of the Yunkang Series. The specimen was unfortunately left in the field. This find has been briefly mentioned by Lee (1955) but the given picture is so poorly reproduced that nothing can be told definitely about the structure of the prints. Fortunately our Institute kept the photo of it which shows faintly the three toed structure of the track. Its size is estimated from the hammer

and the pencil of the picture and is about 80 mm long and 40 mm wide. In general outline it is similar to the prints of *Kouphichnium lithographicum* of Germany but much larger. It certainly belongs to prints of a Coelurosaur. Its age may be upper or middle Jurassic. The photo is reproduced in plate VIII, lower figure.

Table 3

Age	Forms	Locality
Upper Cretaceous	<i>Oolithes sphaeroides</i> Young <i>Paralligator sungaricus</i> Sun	Changtu Liaoning Tehhui, Kirin
Lower Cretaceous		
Upper Jurassic or Middle Jurassic	<i>Yabeinosaurus tenuis</i> Endo <i>Teilhardosaurus carbonarus</i> <sup>1)</sup> Shikama <i>Monjurosuchus splendens</i> Endo <i>Manchurochelys manchuensis</i> E. & S. <i>Manchurodon simplicidens</i> Yabe and Shikama <i>Endotherium niinomii</i> Shikama	Ihsien, Liaoning and Lingyuan, Liaoning Fusin Series, Fusin, Liaoning Gaboten (?), Liaoning Fusin, Liaoning
Middle Jurassic or Lower Jurassic	<i>Changpeipus carbonicus</i> , new genus and new species to be described below	Base of the Fusin coal-bearing beds Fusin, Liaoning
Lower Jurassic or Upper Triassic	<i>Jeholosauripus s-satoi</i> Yabe, Inai and Shikama	Yangshan, Liaoning

The other information of the footprints is given by Prof. P. L. Yuan who told me personally that he has collected a footprint together with plant remains from the Jurassic beds of Sinkiang. The specimen is at least not available for study at present, although it is brought back.

All these data indicate that footprints are richly represented in China. Most of these finds were made accidentally. If only more field explorations can be made, China may be proved to possess much footprints than we know now.

#### DESCRIPTION OF NEW FOOTPRINTS

There are three localities with footprints discovered during the last few years either by our Institute or by geological field parties. They are described in the following lines:

1) According to Shikama, the Fusin Series with *Teilhardosaurus* and *Endotherium* lying above the Shahai Series with the *Lycoptera*. But in the specimen of the new *Yabeinosaurus* a *Lycoptera*-fish is preserved. This suggests strongly that either all the fossils are derived from the same general formation or we have to deal with more than one level of the fish horizons. This is a question to be cleared later.

## 1. Footprints from Huinan and Fusin

### *Changpeipus carbonicus* new genus and new species

**Material. Holotype.** Three footprints preserved in one slab. plates IV and V referred specimen: A single footprint plate VI Cat. No. V2472 and 2470 respectively.

**Localities and horizon.** V2472 from Sungsankang coal mine, Huinan, Kirin<sup>1)</sup>. V2470 from the opening cutting coal mine, Haichou, Fusin, Liaoning<sup>2)</sup>. All Middle or Lower Jurassic.

**Description of the type.** The footprints of Sungsankang have been discovered during the course of the operation of the coal mine and were first observed by Mr. K. Wang and others, the geologists of the mine. There are seven complete footprints preserved in a area about two to three square meters and some fragmentary part of the same, thus footprints altogether as shown in fig. 1 a sketch made by Mr. S. C. Wang, our field collector. One of the better preserved footprints (marked in the sketch as 4) has been excavated by the Museum of Kirin province at Changchun and the other three marked in figure as 2, 2a and 3 have been collected by Mr. Wang for our Institute.

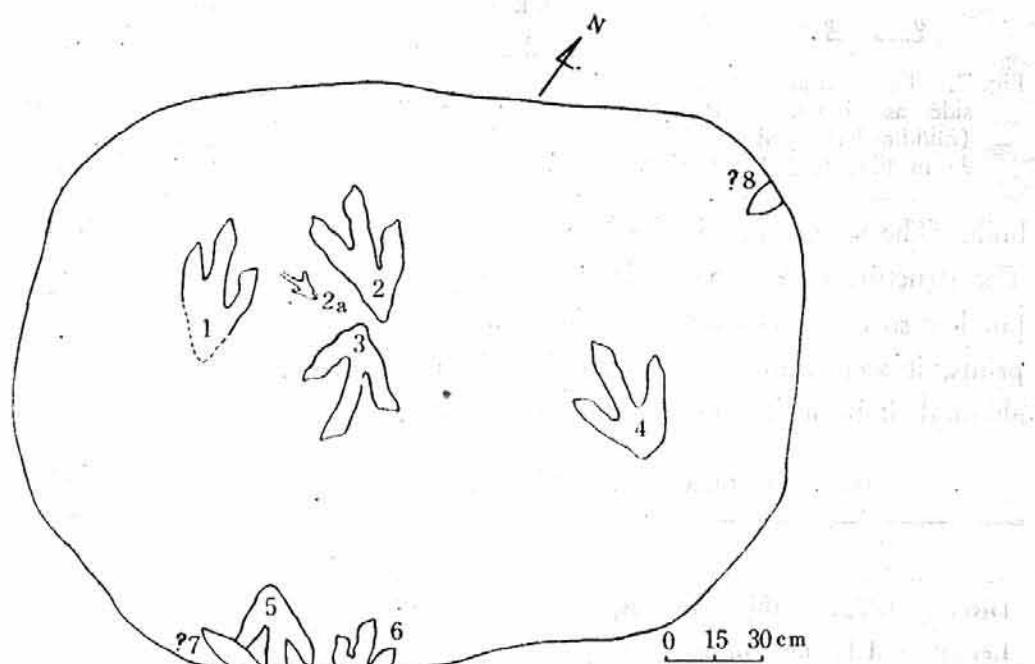


Fig. 1. Sketch of the footprints of Sungsankang, Huinan as seen on the roof of sandstone in the coal series of the Coal Mine. The footprints number 4 has been excavated by the Museum of Changchun, Kirin and the numbers 2, 2a and 3 have been collected by Mr. S. C. Wang of the Institute and were described in the present paper. As indicated in the picture, the claw impressions were mostly preserved when first found.

As shown in the sketch, these footprints are evidently made by at least two animals, but no other detail can be said with certainty. All the prints are preserved as negatives.

1) 吉林輝南松杉崗煤矿。

2) 辽寧阜新海州。

There is no trace of the preservation of the hallux and other trace such as the tail.

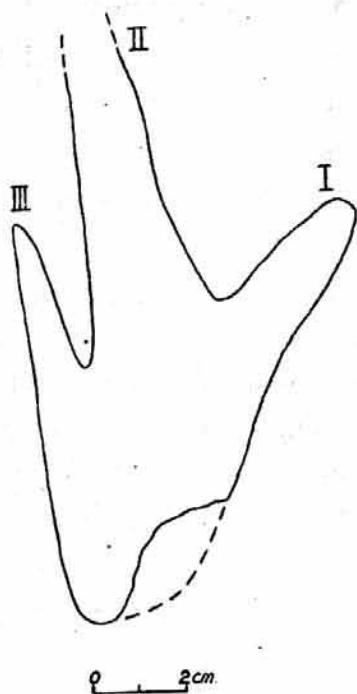


Fig. 2. The manus print of right side as shown in Plate IV (middle left) and marked as 2a in Fig. 1. 2/3 nat. size.

In the two bigger prints here described belonging to the foot, the impressions of the claw are faintly indicated in both middle toes. Both footprints are oriented in opposite direction and surely as representatives of two individuals. Both are belonging to the right side and only 67 mm apart from heel to heel. They are black in color. The matrix is very fine grey sandstone. The outline of the footprints is typically deltoid with the three toes (II-IV) radiating from the heel of the pad which forms a triangular area. In most cases the pad can be clearly observable, certainly II, 2; III, 3 and IV, 3. The second toe is distinctly shorter than the fourth one.

On the same slab, at the left side of the above described two footprints, there is a much smaller track belonging certainly to the prints of the manus. It is shown in figure 2. The tip of the longest toe and part of the heel are less clear and damaged. The first toe projects more sideways. Although it is about the same length as that of the third one but it is much strongly

built. The second one is the longest one. The third toe is the smallest and rudimentary. The structure of the manus is comparable with hand of Jurassic carnivorous dinosaurs but less so of Cretaceous ones. Since it is found so close together with the other footprints, it seems no doubt to consider it as the handprint of the here described form, although it belongs certainly to another individual.

Table 4 Measurements of *Changpeipus carbonicus* (in millimeters)

	V2472,2	V2472,3	V2472,2a	V2470
Distance between the lateral tips	193	234	70	210
Length and breadth of II (length measured from the base of the heel)	270×58	238×43	99×14 (I)	158×52
Length and breadth of III (including the claw)	360×67	383×70	?133×24 (II)	292×60
Length and breadth of IV	300×65	264×43	84×10 (III)	244×52
Divarication of II and IV	65.2°	80°	55° (I4III)	92°
Divarication of II and III	25°	25°	35° (I4II)	29°
Divarication of III and IV	20°	40°	18° (II4III)	48°

**Description of the referred specimen. V2470.** The specimen from Fusin has been collected by C. W. Kou of the Institute of Geology and Paleontology, Academia

Sinica at Nanking when he worked in that region. According to him it was derived from the basal part of the Fusin coal-bearing beds, the Haichow Series, although it was not collected *in situ* but discovered from the debris left by the mine. According to the field observations of many geologists this coal-bearing series is younger than that of Huinan with the above described footprints with no definite paleontological prove.

This footprint is also a negative one and belongs to the left side. It is dark grey in color same as the matrix made of fine muddy sandstone which is lighter in color. As shown in the above table the size of this footprint is smaller than the other two but much larger than the *Jeholosaurus s-satoi* described above. Structurally, the lateral tips or toes are more expanded and consequently the posterior end of the heel bears a much larger angle. Otherwise, I did not see any noticeable reason in not regarding the present specimen as belonging to the same species as the Huinan footprints. In all the three toes the impression of the claws are better preserved especially that of IV. The segmentation of the pad is less clear than the other two but certainly the same as that of the Huinan specimens.

**Comparison and discussion.** As mentioned above, morphologically the here described three footprints belong to a single species. With the exception of the larger size the structure is basically the same as that of *Jeholosaurus s-satoi*. The heel of the present form is, however well developed and the divarication is much greater too. In addition the Huinan specimen is about three to four times larger than the Chengteh specimen. It is still larger than the largest species of *Anchisaurus* (*A. minusculus*) which is the largest form among this genus. The most interesting fact is the presence of the print of the manus which suggests that our form is a carnivorous dinosaur and not a Coelurosaurian dinosaur.

All these facts show that we have to deal with a new form genus for which the name *Changpeipus carbonicus*, new genus and species is proposed. Its diagnosis may be given as follows:

Footprints with tridactyl, no trace of hallux. Size 3—4 times larger than *Jeholosaurus s-satoi*. General outline deltoid, semi-plantigrade. Fourth digit projecting much longer than the second one. Manus print present with digits I—III. III rudimentary.

Same as in *Jeholosaurus s-satoi* the present form belongs zoologically to a saurischian dinosaur. But by presence of the print of the hand, the enormous size and heavy shape of the footprints it is certainly that those prints belong to a carnivorous dinosaur. In the Jurassic time the carnivorous dinosaur is so little known and in the North-Eastern provinces total unknown, it is impossible to say to which form of dinosaur the footprints may belong.

*Jeholosaurus s-satoi* is restricted to the Upper Triassic or Lowest Jurassic. The level of the strata with the *Changpeipus* is definitely higher than that with *J. s-satoi*. In the current stratigraphical correlation, both the two footprints bearing beds from Huinan and Fusin

are considered as Upper Jurassic. As far as the footprints are concerned it seems quite possible that the lowest part of these series may be older, most probably of Middle Jurassic, if not Lower Jurassic. As the exact horizons of the various known vertebrates and other fossils are not clearly known, it would be premature to give a definite conclusion at present.

## 2. Footprints from Yi-ping, Szechuan

### *Yangtzepus yipingensis*, new genus and new species

**Types.** Three footprints one of manus and two of pes. The best preserved and large one is selected as the type and the other two as co-types, field number Ao88, No. 42. Cat. number of the Institute, V. 2473.

**Horizon and locality:** Upper Jurassic of the lower part of the Chiating Series from Kuanyinchon, Kaichinhsiang, Kuanyin district, Yiping, Szechuan<sup>1)</sup>.

**Diagnosis.** Tridactyle footprints with the three digits closely connected. The lateral digits of the hand divergent distinctly. Lateral digits of the foot rather long and subequal in length, III well separated from the heel. The pad number of the foot clearly shown, 2 in II; 3 in both III and IV. Certainly plantigrade. Skin impressions coarsely granulated.

**Description.** The type specimen is completely preserved. The entire negative print is about 10 mm elevated from the matrix which is the typical brick red sandstone. The three digits are closely situated each other so that the second and the fourth digits are nearly parallel in position. All the digits are subequal in breadth throughout the whole length, only the rounded tip part is narrowing remarkably. Although the segmentation of the pad is not strong but can be clearly recognizable, 2 in II and 3 in both III and IV. The middle digit is well separated from the heel part. Most interesting is that the impression of the skin is well preserved, showing as a sort of coarsely granulated or vermiculated pattern, it belongs to the left side.

The other footprint is also a left one. It is somewhat smaller than the type. The whole print is more elevated from the rock, more than two centimeters. The surface of the fingers is partly damaged, either during the excavation or transportation. Morphologically it is exactly the same as the above described specimen. The skin impression is also shown where the surface is well preserved. Obviously it represents a second individual.

The third specimen is much damaged, especially the tip part. But there is no slightest doubt that it is a real print, because the preserved part shows the same granulation of the skin impression. It is also a negative mould but is hard to decide to which side it belongs. It is much smaller than the other two specimens. The lateral digits are distinctly divergent. The middle toe is well separated from the heel. It is hard to decide

1) 四川宜宾观音区改进乡观音冲。

about the segmentation of the pad. It belongs certainly to the hand. Since it was found together with other two specimens it is most probably that it belongs to the same animal.

Table 5 Measurements (in millimeters)

	Specimen A (the type)	Spc. B	Spc. C (the hand)
Maximum length	290	210	?141
Maximum breadth	155	113	?102
Distance between lateral tips	103	94	94
Length and breadth (from heel to tip) of II	183×53	170×39	106×—
Length without the heel pad of II	129	121	—
Length (without the heel) and breadth of III	160×63	141×49	90×45
Length from tip to heel and breadth of IV	185×—	181×42	112×—
Divarication between II and IV	81	77	75

**Comparison.** The peculiar structure of the here described footprints are so characteristic that no other known form can be compared with our form closely. The geological age is so young that it is useless to compare them with the rich footprints of the Triassic time. In comparison with the footprints of the late Jurassic and Cretaceous footprints given by Kuhn (1958) there is no single one shows even the slightest resemblance. The nearly parallel position of II and IV, the rather long extending of the same and the median size of the Chinese form exclude clearly from any other known tracks. We consider, therefore, them as a new form for which the name *Yangtzepus yipingensis*, new genus and new species is proposed. The generic name refer to the Yangtze River and the specific name the district from where the interesting footprints were found at the south bank of the named river.

It is the first time that vertebrate trace has been recorded from the Chiating Series. This formation is long considered as Cretaceous but the primitiveness of the footprints suggests that at least the lower horizon of the series may belong to somewhat older age—Upper Jurassic. Since the Kuangyuan Series is now considered to inclusively Middle Jurassic, this suggestion may be not far from the truth.

It is almost certain that *Yangtzepus yipingensis* belongs zoologically to ornithischians but the present data is not sufficient to give a more precise group of animal.

It is of great interesting to ascertain the presence of the impression of the skin of the foot. Unfortunately the three specimens were collected separately, so that no other details concerning the pose of the animal can be detected.

### 3. Footprints from Laiyang, Shantung

#### *Laiyangpus liui*, new genus and new species

**Material.** A slab with numerous footprints. V2471.

**Horizon and locality.** Upper Jurassic from the Laiyang Series. Locality, Peiputze, Laiyang, Shantung<sup>1)</sup>.

**Diagnosis.** Small footprints. Hand with three toes and foot with four toes. Apparently the first finger of the foot and the first and the fifth of the hand are not preserved. Fingers slender and sharply pointed, all more or less parallel in position. Caudal impression surely present.

**Description.** There are about 85 more or less recognizable footprints preserved in a slab, 950 mm long and 420 mm wide, made of light brownish yellow fine corned sandstone. This interesting collection was made by a field party of our Institute in 1951. It was found by T. S. Liu, then my collaborator, during that work season.

According to the field observation, the footprints bearing level belongs to the Laiyang Beds with numerous horizons of *Lycoptera* and insects remains. The age of the beds is now considered as Upper Jurassic if not still older.

The footprints are distributed on the slab at random. They are so crowded each other, especially at the right part of the slab (Plate IX), it is difficult to identify the number of individuals and the relationship of the anterior and posterior limbs. Yet, most of the prints direct more or less to one direction (downwards in plate IX and X). Besides the footprints, there are a few rod-like impressions, also negative, mostly about 30 mm long. They represent surely the trace of the tail. Two consecutive ones are clearly observable at the lower and left corner of plate X. Their relationship with the footprints is, however, difficult to detect.

The footprints can be easily distinguished in two groups. Those mostly with three toes belong to the hand and those with four toes belong to the foot. All the finger impression are sharply pointed and nearly parallel in orientation. The handprints are comparatively smaller but not profoundly. The length of the toes vary considerably due to the strength with which the animal trod the ground. Length of the hand ca. 12—19 mm and the maximum width, ca. 17—23 mm. Length of the foot, ca. 18—22 mm and the maximum width, ca. 21—26 mm.

**Comparison.** The Laiyang footprints are at least one third smaller than *Kuang-yuanpus* from Szechuan. The general structure is very much the same especially the parallel position of the toes and the sharpness and the slenderness of the digits. But in the present footprints the heel part is exclusively missing. It seems that the animal walked or better jumped mainly by the tips of the toes. In this case I would like to

1) 山东莱阳北泊子。

consider the Laiyang footprints as representing a separate genus for which the name *Laiyangpus liui*, new genus and new species is proposed. The specific name is dedicated to Mr. T. S. Liu who has collected this interesting specimen.

The Chinese form is very similar to the footprints from Schilfsandstein and Weilheim. Even the size is very close each other. It is almost certain that our form belongs to the same zoological group that is Coelurosauria.

Although the geological age of the Laiyang Beds is considered as Upper Jurassic, I would not be surprised if the footprints bearing beds may representing some what older horizons, since both the European related forms and the footprints of Kuangyuan belong to Middle Jurassic rather to the Upper.

Ecologically the locomotion of the animal must be also in jumping manner as correctly pointed out by Huene, although it is not so clearly indicated in our specimen.

### CONCLUSIONS

The above described new form of footprints increase considerably our knowledge of ichnolithes in China. In most cases, if not all, they were found accidentally. They are, however, represent an interesting branch of the vertebrate paleontology. With the exception of the footprints observed from Mingho, which is Cenozoic in age, all the others belong to Mesozoic strata.

The so far known fossil footprints of Mesozoic era in China may be tabulated as follows:

Table 6

Geological age	Forms	Zoological group
Cretaceous		
Upper Jurassic	<i>Yangtzeopus yipingensis</i> <sup>1)</sup> <i>Sinoichnites youngi</i> <i>Laiyangpus liui</i>	Ornithischian Iguanodonts Coelurosauria
Middle Jurassic	<i>Kuangyuanpus szechuanensis</i> <i>Changpeipus carbonicus</i> Footprints of Yunkan, Tating	Coelurosauria Carnosaurs Coelurosauria
Lowest Jurassic or Upper Triassic	<i>Jeholosauripus s-satoi</i>	Saurischians

**Acknowledgment.** The Institute of Vertebrate Paleontology and Paleoanthropology is deeply grateful to the following organisations for sending and presenting the

1) The Chiating Series is generally considered as Cretaceous, but the belonging of part of it to the Jurassic is adopted by some geologists. Morphologically, it is better to consider as belonging to Upper Jurassic.

valuable specimens to the Institute and for their help in various manner during our work in the field: The Bureau of Geology of South-West, the Sungsankang Coal Mine of Huinan and the coal Mine of Fusin. I wish also to thank Mr. C. V. Kuo of the Institute of Geology and Paleontology for sending the specimen of Fusin for study and many valuable suggestions concerning the age of various formations in North Eastern provinces. During the preparation of the manuscript, I am very thankful to many colleagues of our Institute notably Messrs. C. F. Wang, W. L. Shen, S. K. Yeh, W. L. Huang and Mrs. Y. W. Liu who helped me in making photographs, sketch and data of field observations.

### Selected References

**Baird, Donald**, 1957. Triassic Reptile Footprint Faunules from Milford, New Jersey, *Bull. Mus. Comp. Zool. at Harvard College*, **117** (5).

**Endo, R., and T. Shikama**, 1942. Mesozoic reptilian fauna in the Jehol mountainland, Manchuria. *Bull. Cent. Natl. Mus.*, Manchuria, (3): 1—20.

**Huene, F. v.**, 1932. Die fossils Reptilordnung Saurischia. *Mon. Geol. Pal. Berlin*.

**Kuhn, Oskar**, 1958. Die Fährten davorzeitlichen Amphibien und Reptilien. *Verlagshaus Meisenbach KG*, Hamberg.

**Lee, H. H.**, 1955. On the Age of the Yunkang Series of the Tatung Coal Field in North Shansi. *Acta Palaeontologica Sinica*, **3** (1).

**Lull, Richard Swann**, 1953. Triassic Life of the Connecticut Valley. *State Connecticut State Geol. Natl. Hist. Surv. Bull.* No. 81.

**Shikama, Tokio**, 1942. Footprints from Chinchou, Manchoukuo, of *Jeholosauripus*, the Eo-Mesozoic Dinosaur. Reprinted from the *Bull. Cent. Natl. Mus. Manchoukuo*, No. 3.

\_\_\_\_\_, 1947. *Teilhardosaurus* and *Endotherium*, New Jurassic Reptilia and Mammalia from the Husin Coal-Field, South Manchuria. *Proc. Japan Acad.*, **23** (7).

**Teilhard de Chardin & C. C. Young**, 1929. On Some Traces of Vertebrate Life in the Jurassic and Triassic Beds of Shansi and Shensi. *Bull. Geol. Soc. China*, **3** (2).

**Yabe, H., Inai, Y. & T. Shikama**, 1940. Discovery of Dinosaurian Footprints from the Cretaceous (?) of Yangshan, Chinchou. Preliminary Note. *Proc. Imp. Acad. Tokyo*, **16** (10).

**Young, C. C.**, 1943. Note on Some Fossil Footprints in China. *Bull. Geol. Soc. China*, **13** (3—4): 151—154.

## Explanation of Plates

Pl. I. The valley near Ssuehia-tzu, Yangshan with *Jeholosauripus s-satoi*. Upper figure, part of the valley; Lower figure, a closer view. Photo. taken by Mr. W. L. Huang.

Pl. II. *Jeholosauripus s-satoi* from Liukou, Chengteh. 2/9 nat. size.

Pl. III. *Jeholosauripus s-satoi*. A single footprint marked in plate II by white circle in natural size. Notice the extreme coarse nature of the matrix.

Pl. IV. *Changpeipus carbonicus*, new genus and new species. Two footprints in opposite direction 1/4 nat. size. Sungsankang, Huinan.

· *Changpeipus carbonicus*, new genus and new species. The print of the manus at the left side of the two large ones 1/4 nat. size.

· Pl. V. *Changpeipus carbonicus*, new genus and new species. Lower one is the same as the upper figure of plate IV and the upper one the lower figure of plate IV. Both in 1/4 nat. size.

Pl. VI *Changpeipus carbonicus*, new genus and new species. A left footprint from Haichow, Fusin, in 1/2 nat. size.

· Pl. VII. *Yangtzeipus yipingensis*, new genus and new species. Two footprints in 1/2 natural size from Kuangyinchon, Yiping.

Pl. VIII. Upper figure. *Yangtzeipus yipingensis*, new genus and new species, from Kuangyinchon, nat. size.

Lower figure. Ichnolite indet. from Yunkang, Tatung, N. Shansi observed by H. H. Lee. This is reproduced from Lee paper using another copy, in order to show better the divergence of the toes. Judged by the hammer and the pencil it is about 1/4 in nat. size.

Pl. IX. *Laiyangpus liui*, new genus and new species. 1/6 nat. size.

Pl. X. *Laiyangpus liui*, new genus and new species. The same of the right part in 1/3 nat. size, Peiputze, Laiyang.









